Draft of the cover page and outline

Biomimetic and Biologically-Inspired Technologies

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Outline

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   1.2 Copying versus adapting concepts from biology - bio-inspired and bio-derived
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   1.4 Biomimetics in science and engineering
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   2.1 Areas that define a biology for adaptation
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5. **Genetic Algorithm: Imitating Evolution and Natural Selection** - Tammy Drezner and Zvi Drezner, California State University, Fullerton
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   5.2 The General Framework of a Genetic Algorithm.
   5.3 Components of a Genetic Algorithm.
      5.3.1 The Fit function.
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6. **Mobility, Manipulation and Robotic Mechanisms** – David Hanson, University of Texas at Dallas and Human Emulation Robotics, LLC
   6.1 Flying, Walking, Crawling
   6.2 Behavior, expressivity
   6.3 Structures from cell elements to full scale

7. **Molecular Machines - Molecular Machines; Molecular Motors; Bio-Nano-Devices** - C. Mavroidis[1], A. Dubey[1], G. Sharma[1], M.L. Yarmush[2]
   [1]Department of Mechanical and Aerospace Engineering, [2]Department of Biomedical Engineering, Rutgers University, NJ
   7.1 Introduction: Definition, Significance and Classification of Molecular Machines

7.2 Protein Based Molecular Machines
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7.5 Other Types of Molecular Machines
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8. Molecular Design of Biological and Nano-Materials – Shuguang Zhang, MIT, et al
8.1 Design, synthesis and fabrication of biological and nanomaterials at the molecular scale.
8.2 Nanobiotechnology through molecular self-assembly as a fabrication tool.
8.3 Basic engineering principles for micro- and nano- fabrication based on molecular self-assembly phenomena.
8.4 Chemical complementarity and structural compatibility through noncovalent weak interactions.
8.5 Self-assembling systems - models to study molecular antenna for programmed assembly, surface engineering, fabrication of nanoscaffold, to nanobiotechnology.
8.6 Peptide detergents stabilize membrane proteins and complexes

9. Engineered Muscle Actuators: Cells & Tissues – Robert G. Dennis, Dr. of Mechanical Eng., University of Michigan; and Hugh Herr, MIT
9.1 Introduction
9.2 Muscle: Nature's Actuator
9.3 Why Use Muscle for Machines?
9.4 Tissue Sources: Organ and Cell Culture
9.5 Tissue Interfaces: Tendon, Nerve, and Artery
9.6 Muscle Maintenance: Organ and Cell Culture
9.7 Muscle Control: Functional Electrical Stimulation
9.8 Case Study: A Muscle Actuated Aqueous Robot
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10. Artificial muscles using Electroactive Polymers (EAP) – Yoseph Bar-Cohen, JPL
10.1 Polymers that can be stimulated to change shape or size
10.2 The EAP technology infrastructure
10.2.1 Electroactive Polymers (EAP) materials
10.2.1.1 Electronic EAP
10.2.1.2 Ionic EAP

10.2.2 EAP characterization
10.2.3 Expected applications
10.3 Platforms for demonstration of EAP
10.4 Future Expectations

11. Bio-sensors the equivalent of the human senses – Luke P. Lee and Robert Szema, Berkeley Sensor & Actuator Center, Department of Bioengineering, UC Berkeley
Use of sensors that emulate the human senses, interfacing biology/sensors (implants of microchips for vision, hearing, etc.)

Introduction
11.1 Camera Eyes
A fluidic adaptive lens
An artificial cephalopod eye
A foveated imaging system
11.2 Compound Eyes
Apposition Compound Eyes
Superposition Compound Eyes
Hybrid Apposition/Superposition Compound Eyes
11.3 Other Biomimetic Approaches
Brittlestar eyes
Melanophila acuminate beetle
11.4 Conclusion

12. Multifunctional Materials and Devices – Sia Nemat-Nasser, University of California, San Diego (UCSD)
Material compositional and morphological arrangements that perform more than one function, possibly including self-repair following such model as the bones operating as structural elements and blood factory

13. Defense and attack strategies and mechanisms in biology – Julian FV Vincent, Centre for Biomimetics & Natural Technologies, Dept of Mechanical, The University Bath, England; and Roger T. Hanlon, Marine Resources Center, Marine Biological Laboratory, Woods Hole, MA
Strategic attack and defense in biology, causes (enemy, territorial, survival, search for food, mating, etc.), destruction tools (nails, teeth, tail, horns, …), fear as a security alert level in the defense mechanism, defense tools: camouflage, mobile home, use of chemistry (poison, ink, adhesives, etc.),

14. Biological Materials in Engineering Mechanisms – David Kaplan, Tufts University, Medford, MA
Focus:

biology of the systems
molecular designs and mechanisms
structural hierarchy
approaches used to mimic these features (bio and nonbio)

Topics:
silks - structure, function, engineering
suction cups (Gecko), velcro
artificial muscles
crustacean exoskeletons

15. Functional surfaces in biology - mechanisms and applications - Stanislav N. Gorb, MPI for Metals Research, Stuttgart, Germany

15.1 Introduction
15.2 Functions of biological surfaces
15.3 Surfaces of joints: anti-friction and wear resistance
15.4 Nature's gluing technologies
15.5 Locomotory attachment devices: temporary enhancement of adhesion and friction
15.6 Self-cleaning: anti-adhesive surfaces
15.7 Biomimetics: what can we learn from evolution?

16. Biomimetic and biologically inspired control – Zhi-Wei, Lou and Shigeyuki Hosoe, Bio-Mimetic Control (BMC) Research Center, RIKEN, Aichi, Japan

16.1 Review on the development of system control
From N. Wiener's Cybernetics, homeostasis in biological system to feedback control, optimal control, adaptive control, robust control, nonlinear system control,…
16.2 Autonomous decentralized system control
16.2.1 Autonomous decentralized structures and pattern formation in nature systems
Physical systems: Rayleigh-Benard Convection, BZ reaction, dissipative structure
Biological systems:
Organization: Hierarchical structure, neural network structure
Functions: learning, adaptation, self-organization, sensory-motor integration
16.2.2 Autonomous decentralized system modeling and control
Synergetics
Gradient system
Graph structure of network system
16.2.3 Applications in legged locomotion
16.3. Hybrid system control
16.3.1 Modeling of hybrid system – mixed logical and dynamics
16.3.2 Control of MLD – optimal control, tracking control
16.3.3 Application to Multi-fingered hand manipulations
16.4. Dexterous motor learning and control
16.4.1 Bernstein problem and nonlinear redundant motor learning
16.4.2 D.O.F. adaptive control
16.4.3 Mechanical interaction and environmental adaptation

17. Interfacing Microelectronics and the Human Body – Mark Humayun and James Weiland, Doheny Eye Institute, USC, Los Angeles, CA

Brain and Cognitive Sciences (BCS), Vision Science,
Simulated retina, Making blind see

18. Artificial support and replacement of human organs – Pramod Bonde, Johns Hopkins University School of Medicine, Baltimore, MD, USA

18.1. Historical perspective
18.2. Organ replacement
  a. Artificial heart
  b. Artificial lungs
  c. Artificial liver
  d. Artificial kidney
18.3. Artificial limbs and joints (Prosthetics)
18.4. Medical implants and aids
18.5. Limitations of the current support systems
18.6. Future directions

19. Nastic structures - active materials that enact and mimic plant movements - Rainer Stahlberg and Minoru Taya, University of Washington, Seattle WA

19.1 Functions and design of nastic structures in plants (from leaf-moving joints to ion-channels)
19.2 Material and structural requirements for biomimetic actions
19.3 Arranging of bioinspired materials for biomimetic action
19.4 Expected applications and other benefits

20. Applications, Challenges, Outlook - Y. Bar-Cohen, JPL

20.1 Summary of the state of the art
20.2 Area of deficiency, pitfalls, concerns and show stoppers to biomimetics
20.3 The vision of the future and outlook for the possibilities
20.4 Challenges
20.5 Concluding remarks